

Interim Conceptual Site Model

February 6, 2014

Document Structure

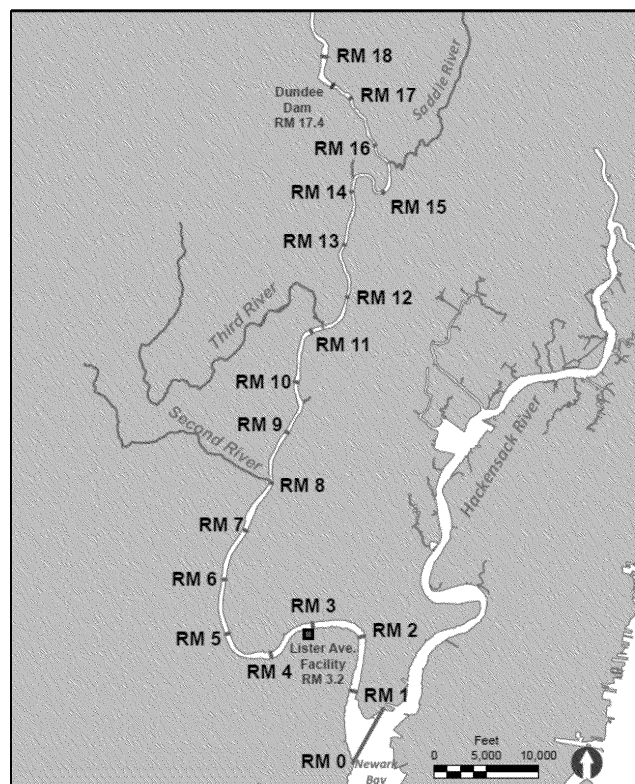
- Main Body
 1. CSM Overview and Components
 2. River Characteristics and Setting
 3. Environmental Conditions
 4. Risk Receptors and Pathways
 5. Fate and Transport
 6. Summary
- Appendices
 - A – Evaluation of the Low Resolution Coring Data
 - B – Overview of the LPR Historical 2,3,7,8-TCDD Source and the Support for Its Regional Dominance

CSM Overview

- Describes current understanding of physical, chemical and biological processes controlling fate and transport in the system
- Uses data from past studies and extensive data collected as part of RI/FS process
 - Bathymetric surveys
 - Physical, chemical and radiological sediment data
 - Physical and chemical water column monitoring (CWCM)
 - Benthic and fish tissue analysis
- CSM is being refined to reflect new/additional information received since the document was prepared

River Characteristics and Setting

- Three major classifications
 - Freshwater River Section
 - Transitional River Section
 - Brackish River Section
- Particle size transitions from coarse to silt/fine grained upstream to downstream



River Characteristics and Setting

- Heavy urbanization and industrialization has
 - Resulted in a broad range of contaminant loadings from a multitude of sources
 - Severely degraded habitats and adversely impacted the benthic community
 - Brought about altered shoreline and several bridge and utility crossings
 - Introduced non-chemical stressors to the ecosystem
- Distinguished from other urban sites by atypical levels of 2,3,7,8-TCDD in sediments

Contaminants

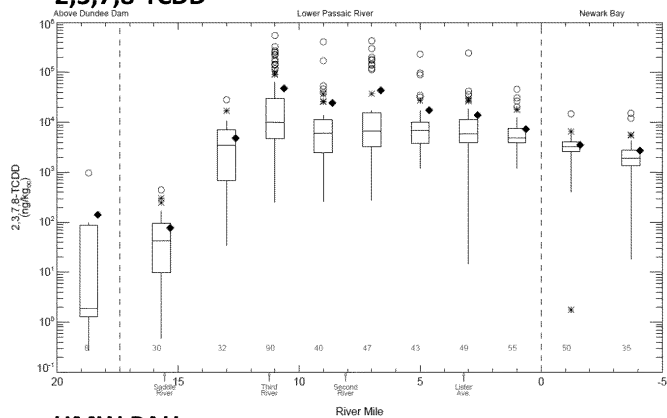
- Contaminants examined include
 - 2,3,7,8-TCDD
 - PCBs
 - HMW and LMW PAHs
 - DDx, Dieldrin, Chlordane
 - Mercury, Copper, Lead

Sediment Data Treatment

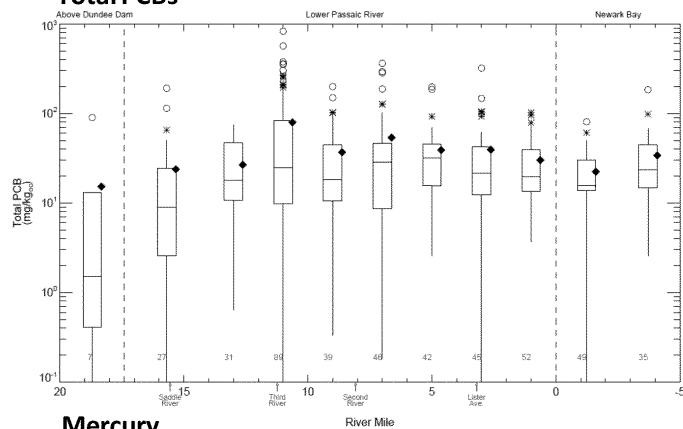
- Sediment data OC-normalized to reflect hydrophobic nature of contaminants and differences in sediment TOC
- Data grouped spatially before plotting
 - 2-mile bins within lower 14 miles of LPR
 - RM 17.4 to RM 14 and RM 20 to RM 17.4 treated as single bins
 - Newark Bay divided equally – RM 0 to RM -2.475 and RM -2.475 to RM -4.95
- Only post-2000 data used
 - Provide complete spatial coverage throughout LPR
 - Consistent set of objectives and protocols

Surface Sediment Concentrations

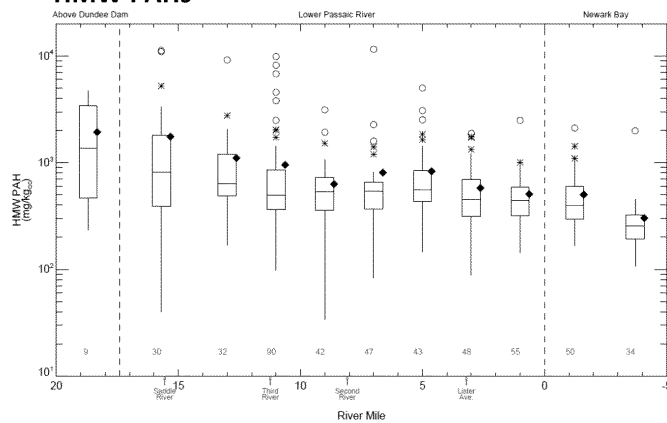
2,3,7,8-TCDD



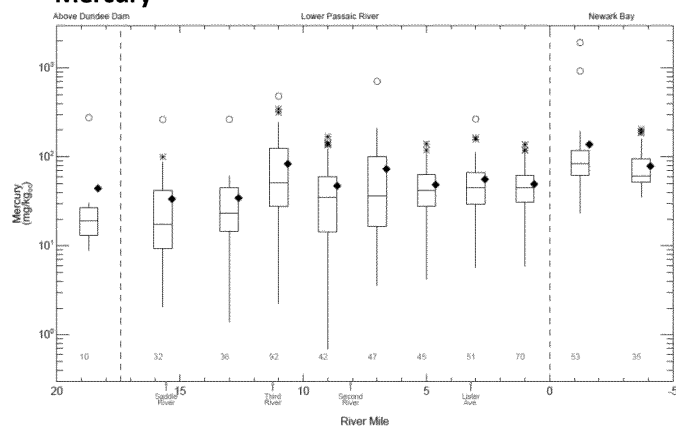
Total PCBs



HMW PAHs



Mercury

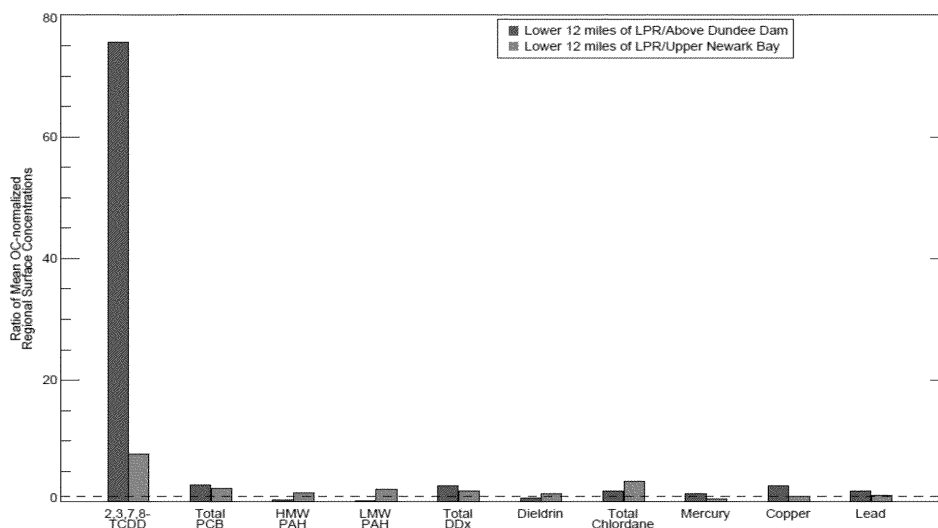


Preliminary CSM – For Discussion Purposes Only

Surface Contaminant Concentrations

- Surface contaminant concentrations in lower 12 miles are well correlated with surface 2,3,7,8-TCDD concentrations
- Within lower 12 miles, concentrations exhibit no particular large scale trends
- Outside of lower 12 miles, trends differ from 2,3,7,8-TCDD
- Indicates influence of upstream, downstream, and/or watershed sources for different contaminants

External Sources



- Average surface sediment 2,3,7,8-TCDD concentration in Lower LPR is substantially higher than those in Upper Passaic River and Upper Newark Bay
- Other contaminants are generally within factor of 2 to 5 of those in the Upper Passaic River and Upper Newark Bay

External Sources

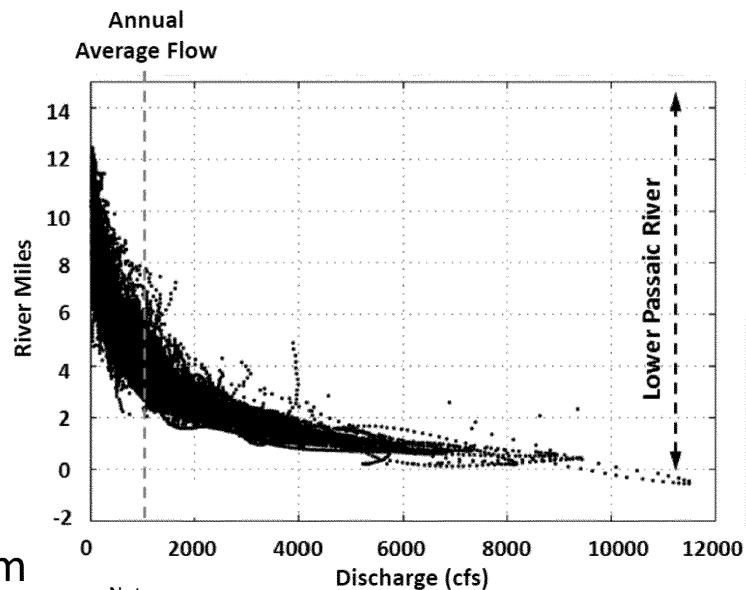
- One or more tributaries can contribute to elevated contaminant levels at least locally for many contaminants
- Insufficient information to understand the relative importance of other potential ongoing sources (i.e., CSOs, direct discharges, etc.)

Fate and Transport

- Major fate and transport mechanisms
 - Estuarine processes
 - Sediments
 - Scour and deposition
 - Sedimentation
 - Sediment stability
- Contaminants
- Natural Recovery

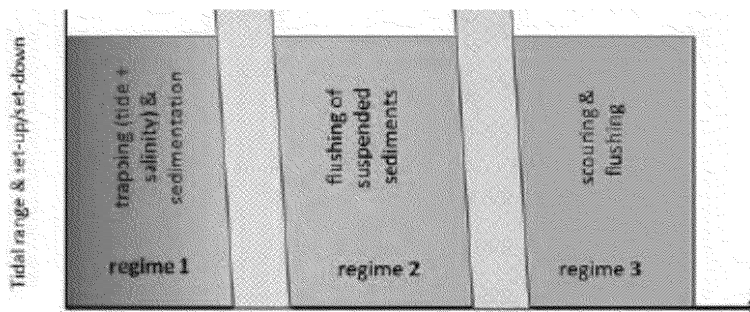
Estuarine Processes

- LPR hydrodynamics governed by
 - River flow
 - Tides
 - Salinity gradients
 - Offshore setup/setdown events
- Estuarine circulation
 - Upriver flow in the bottom portion of the water column
 - Downriver flow in the upper water column
- Location of salt front varies



Note:
Computed salinity intrusion (salt front at 2 ppt, bottom) as a function of river discharge, based on a 10-yr hydrodynamic model simulation (results filtered to remove tidal variability)

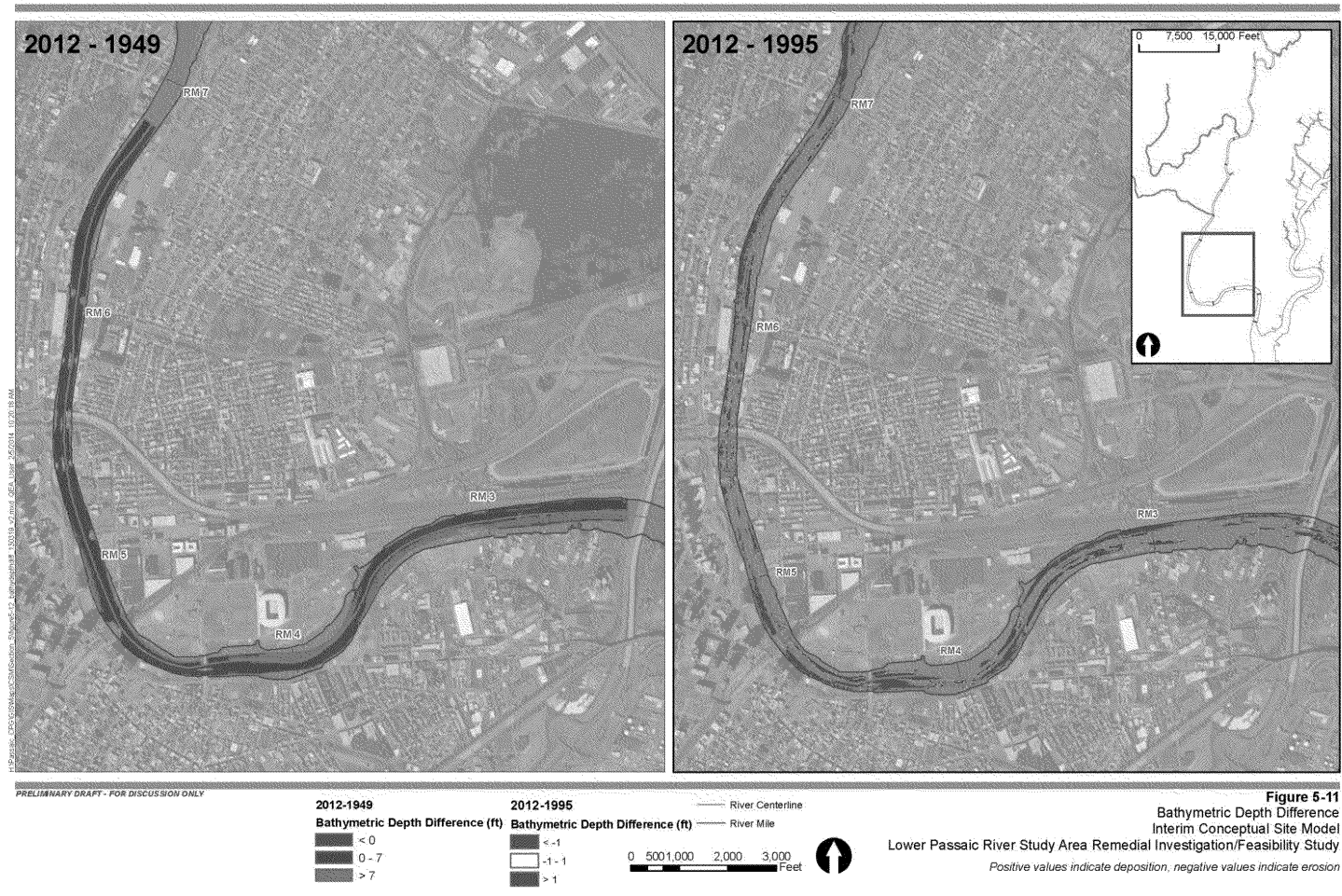
Scour and Deposition



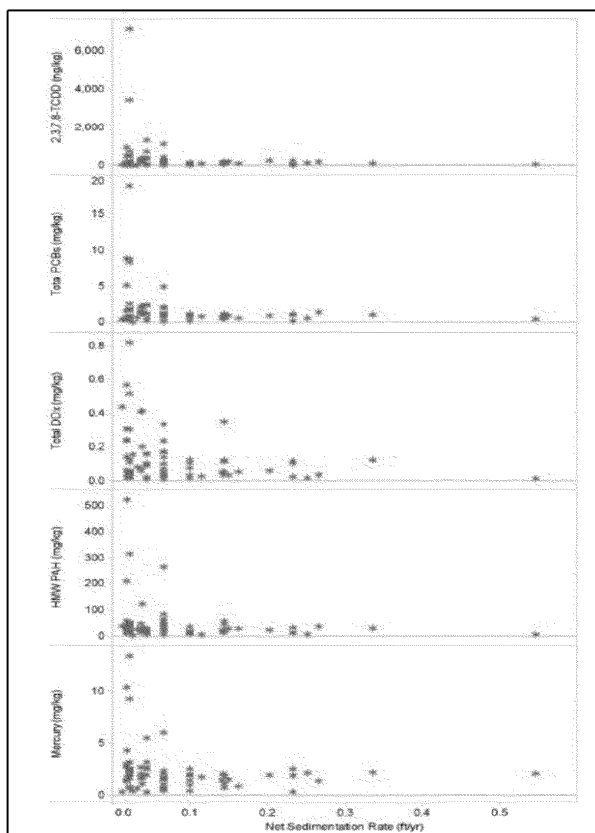
- Transition between regimes a function of river flow
 - Low flows – tidal asymmetry and gravitational circulation dominate, infilling
 - High flows – scour and downstream transport

Net Scour and Deposition

- Estimated from changing bathymetric maps
- Between 1949 and 2010 – the navigation channel from RM 2 to RM 7 was largely net depositional
- Some depositional areas became net erosional after 1995
 - Result of shallower cross section and frequent high flow events since 1995
- Large areas with no change in recent past (2007-2012)
- Areas with cyclic erosion/deposition patterns



Influence of Sedimentation on COPC Levels



- High surface concentrations at locations with low sedimentation rates
- Low sedimentation rates in point bars and mudflats
- Higher sedimentation rates in lower 7 miles and within navigation channel
 - Greater rates when channel was maintained

Contaminant Fate and Transport

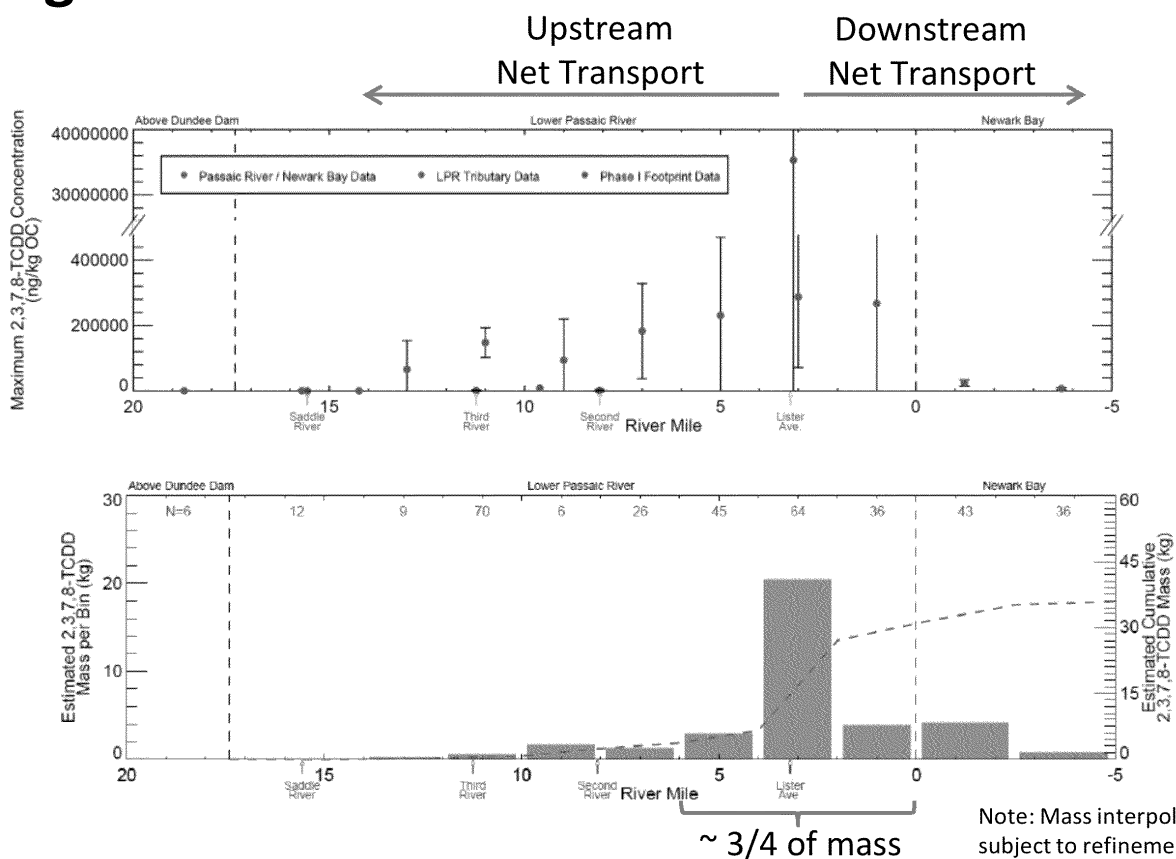
- Processes affecting sediments affect LPR COPCs
 - Estuarine/tidal processes
 - Tidal currents □ resuspension and deposition
 - Estuarine circulation
 - Event-driven scour
 - Deposition/burial
 - Mixing
- COPC-specific considerations
 - Distribution in sediments (horizontal, vertical)
 - Boundary loadings
 - Sorption, diffusion, and other F&T processes

Contaminant Fate and Transport

- Focus on 2,3,7,8-TCDD to infer transport dynamics of LPR contaminants
 - Dominant historical source □ Lister Ave discharge
- Observations grouped as follows
 1. Long-term Transport □ Sediment bed trends reflect time-integration of transport processes
 2. Short-term Transport □ Water column trends show bed-water column interactions

Contaminant Fate and Transport

Long-Term Trends from Sediment Data



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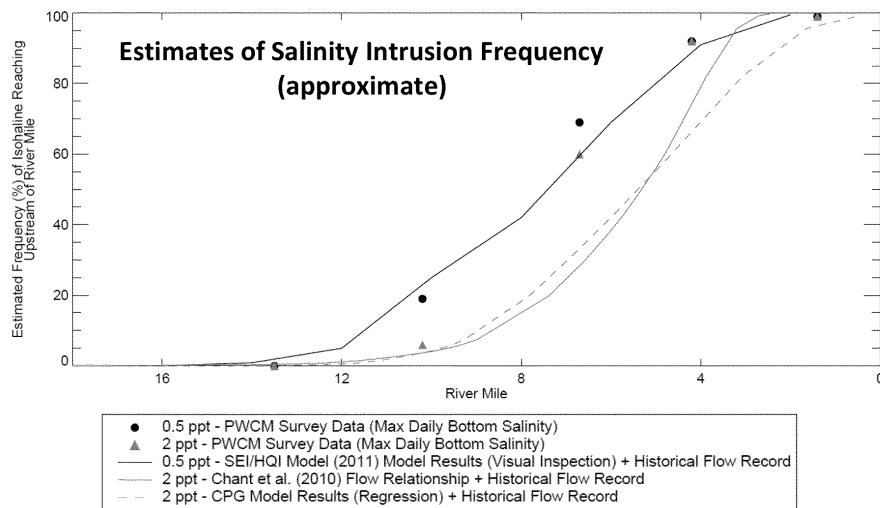
Contaminant Fate and Transport Long-Term Trends from Sediment Data

- LPR was historically an effective contaminant trap
 - About 3/4 of estimated mass in the lower 6 miles
- Net upstream transport to approx. RM 14, reflecting
 - Declining upstream transport potential (estuarine processes)
 - Declining long-term trapping potential (narrower cross-section, less fine sediment deposits)
- Net downstream transport into Newark Bay
 - Declining influence of LPR solids with distance, consistent with settling and mixing with other solids

Contaminant Fate and Transport

Long-Term Trends – Upstream Transport

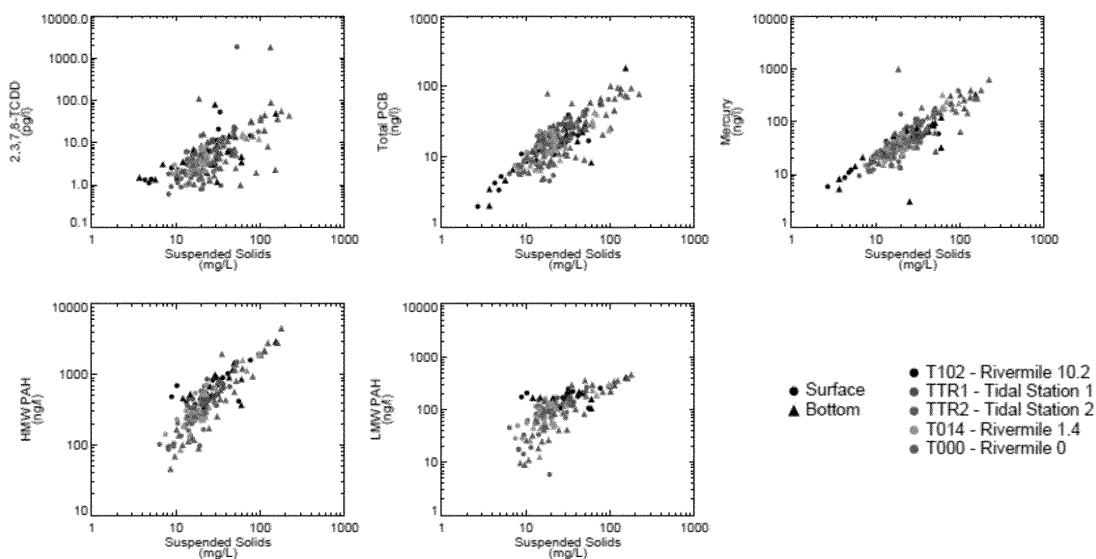
- Upstream transport potential is consistent with salinity intrusion considerations
 - Expected to have been higher in the past
 - Deeper channel
 - Drought in the early-to-mid 1960s



Contaminant Fate and Transport

Short-Term Trends from Water Column Data

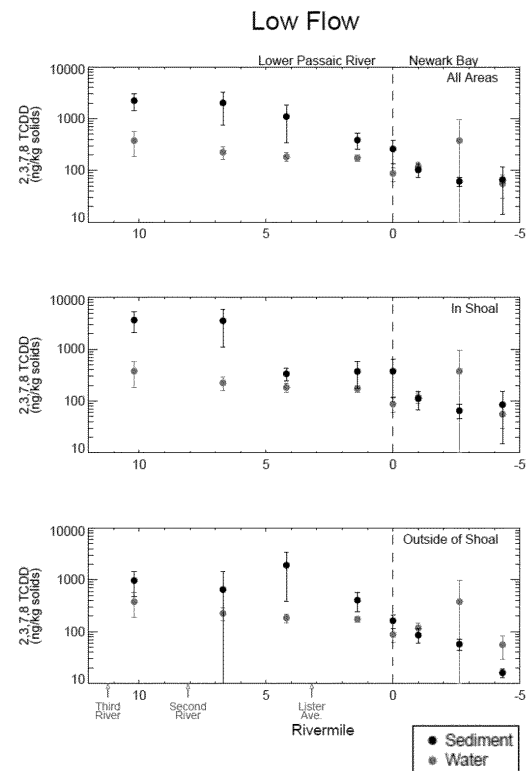
- Water column contaminant concentrations in the LPR exhibit a wide range, spanning orders of magnitude
- Concentrations are well correlated with suspended solids
 - Consistent with particulate phase dominance



Contaminant Fate and Transport

Short-Term Trends – Water Column Fluxes

- Within LPR, mean solids normalized water column 2,3,7,8-TCDD concentrations are generally lower than the mean 0-6 inch concentration of the bed
- Conceptual model: Vertical bed concentration gradients reduce flux to water column
 - Gradient between the parent bed and overlying un-consolidated “fluff” layer
 - Near-surface gradient within the parent bed
- Additional interpretations/effects
 - Tidal resuspension flux may be dominated by areas of lower concentration surface sediments
 - Solids normalized concentrations may reflect dilution by lower concentration solids not originating from the local sediment bed
- Effect is under investigation as part of CFT model development



Natural Recovery

Conceptual Model for Sediment Recovery

- Deposition
 - Introduces particles typically having lower concentrations
 - Down-mixing dilutes the concentrations in the surface sediment layer
- Net Sedimentation
 - Buries higher concentrations
- Resuspension and diffusion
 - Move contaminants out of the sediments
 - Redistributes contaminants

Natural Recovery Patterns for 2,3,7,8-TCDD

- It has been widespread
 - Highest concentrations deposited in the 1950-1960s are typically buried
- It correlates with the rate of net sedimentation
 - Cores with the highest sedimentation rates tend to have relatively low surface sediment concentrations
- It has varied spatially
 - Greater in the lower 6 miles of the river
 - Some shoal deposits (e.g., RM 7.5; RM 10.9) show little evidence of recovery

Natural Recovery

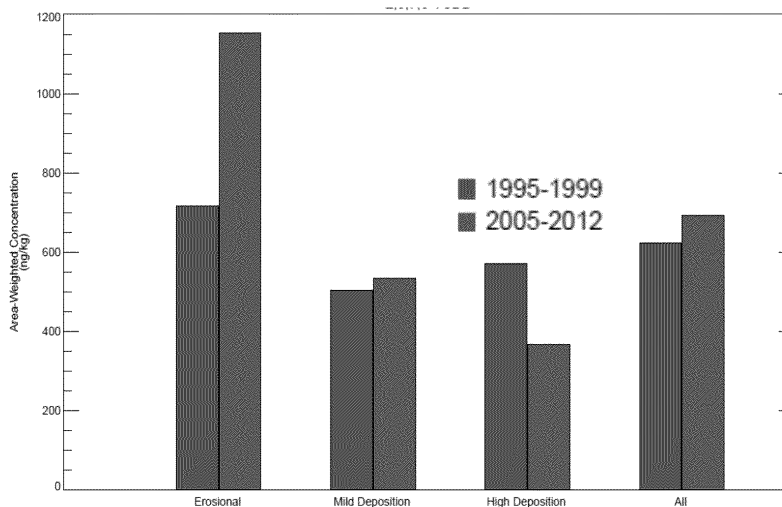
Contemporary Rate – 2,3,7,8 TCDD

- Estimated by comparing RM 1 to 6.8 surface sediment concentrations in the mid-1990s and in the late-2000s
- Gross comparisons of all-data averages show no decline
 - Value of this comparison is compromised by spatial biases between the data sets
- Attempted to overcome the spatial biases by mapping concentrations over the full river bottom
 - Partitioned the river bottom for purposes of mapping
 - Shoals
 - Non-depositional regions of the channel
 - Historically depositional regions of the channel that have experienced erosion back to within 6 inches of the 1966 surface
 - Historically depositional regions of the channel that have maintained more than 6 inches of sediment above the 1966 surface

Natural Recovery

Contemporary Rate – 2,3,7,8 TCDD

- Little change in overall averages, but a spatially variable recovery
- Areas predicted by CPG ST model as
 - Erosional □ show an increase in concentration
 - Depositional at < 1 cm/yr □ show little change
 - Depositional at > 1 cm/yr □ show 30 – 35% recovery
 - Roughly matches the drop in aquatic biota concentrations



Note: Ongoing refinements to mapping may alter the assessment of rate

Natural Recovery

Future Recovery

- Natural recovery may slow in the future
 - Depends on concentration difference between depositing particles and surface sediments
 - Concentration difference declines over time with recovery
 - For several contaminants, at or near regional background
 - The importance of non-recovering areas within the LPR may be increasing, to the extent that they control concentrations on particles depositing in the recovering areas
 - Also depends on sedimentation rates
 - Net sedimentation rates are likely declining, although should on average be maintained at rate of sea level rise